Inspection machine and process

The present invention concerns an inspection machine for printed matter in the form of printed sheets, such as securities, notes, banknotes, passports and other similar documents.

The present invention also concerns an inspection process for printed matter in the form of printed sheets, such as securities, notes, banknotes, passports and other similar documents.

In the field of securities, i.e. banknotes, passports and other similar documents, it is well known to use security features for protecting said documents against forgery. In this field, it is also necessary to produce printed documents with high quality in order to distinguish real printed documents and securities from fake.

Accordingly, the inspection of said printed matter must be carried out in a precise manner with high quality standards to accept only printed documents that fulfil the quality criteria and reject misprinted documents or documents that does not meet the preset quality criteria.

Known inspection machines and quality control machines for printed matter such as securities include (for example) WO 01/85586, WO 01/85457, EP 0 796 735, EP 0 668 577, EP 0 734 863, EP 0 612 042, EP 0 582 548, EP 0 582 547 and EP 0 582 546, the content of which is incorporated by reference in the present application.

It is an aim of the present invention to improve the known inspection machines and processes.

In particular, it is an aim of the present invention to provide an inspection machine and process which optimises the transport and inspection times required for performing inspection of printed sheets.

Another aim of the present invention is to make it possible to build an inspection machine with a compact configuration.

It is a further aim of the present invention to provide a simple and reliable inspection machine and process.

To this effect, the invention complies with the definition of the claims.

The invention will be best understood with reference to drawings in which

Figure 1 shows an embodiment of the inspection machine according to the invention;

Figure 2 shows a block-diagram of an inspection process according to the invention.

In figure 1, an inspection machine is disclosed which comprises a sheet feeder 1 which transfers successive sheets in the inspection machine in a manner known in the art. The incoming successive sheets are transferred by a suction stop drum 2 to a transfer cylinder 3. Preferably, the successive sheets are held on said transfer cylinder by

gripper means placed in a pit of the cylinder, in a manner known in the art.

From the transfer cylinder 3, the successive sheets are taken over by a first inspection unit. This inspection unit is made of a transparent cylinder 4 in which an illumination lamp 5 is placed to illuminate in transparency the sheet carried by the transparent cylinder 4. As is known in the art, the successive sheets are held on said cylinder 4 by gripper means placed in a pit of the cylinder. A camera 6, for example a CCD camera known per se in the art, takes the image created by this illumination.

This image is a transparency image of the printed sheet since the cylinder is transparent and is used to check the position and quality of the features only visible in transparency, for example watermarks. To this effect, the image taken is transferred to a computer device (not shown) with appropriate programs to analyse the data (see for example the above-cited prior art references) and generate a result of the inspection.

The transparent cylinder 4 is made, for example, of plexiglas or other similar suitable material. Since this cylinder is non-metallic, it is possible to control the magnetic properties of the printed sheet, with a magnetic detector 22.

Once this first inspection by transparency has been carried out, the sheet is transferred to a second inspection unit formed by a second inspection cylinder 7 (in direct contact with the first inspection cylinder 4) with a second illuminating means 8, such as a lamp, and a second camera

9. As is known in the art, the successive sheets are held on said cylinder 7 by gripper means placed in a pit of the cylinder. This second inspection unit takes a picture of one side of the sheet on cylinder 7, for example the recto side of the sheet, and is used to control the print quality of said side of the sheet by appropriate computer devices and programs, as is known in the art. For example, this unit could control the register of the securities, banknotes, the colors etc. as is standard in the art (see for example as disclosed in the above-mentioned prior art documents incorporated by reference) and generate a result of this inspection.

This second inspection unit may comprise, in addition, second additional inspection devices referenced 10 and 11 in figure 1 to inspect and check the presence of features, which are not visible such as IR, UV, magnetic features etc. on the sheets. These devices thus may comprise appropriate lamps (UV) and detectors (IR, magnetic) to carry out said additional inspection.

After this second inspection, the inspected sheet is then transferred to a third inspection unit formed by a third inspection cylinder 12 (in direct contact with the second inspection cylinder 7) with a third illuminating means 13, such as a lamp, and a third camera 14. As is known in the art, the successive sheets are held on said cylinder 12 by gripper means placed in a pit of the cylinder. This third inspection unit is similar to the second inspection unit but takes a picture of the other side of the sheet on cylinder 12, for example the verso side of the sheet if the second unit inspected the recto side, and is used to control the print quality of said verso side of the sheet

by appropriate computer devices and programs, as is known in the art. For example, this third unit, as the second unit, could control the register of the securities, banknotes, the colors etc. as is standard in the art (see for example as disclosed in the above-mentioned prior art documents incorporated by reference) with known appropriate devices (computer, programs etc) and generate a result of this inspection.

This third inspection unit may comprise, in addition and similarly to the second inspection unit described above, third additional inspection devices referenced 15 and 16 in figure 1 to inspect and check the presence of features, which are not visible such as IR, UV, magnetic features etc. on the sheets. Accordingly, these additional devices may comprise appropriate lamps (UV) and detectors (IR, magnetic) to carry out said additional inspection.

Once this third inspection is terminated, the sheet inspected is transferred via second 17 and third 18 transfer cylinder to a marking unit to be marked if the inspection has detected a sheet with defects. The marking unit comprises a marking cylinder 19 and a marking device 20. After the marking unit, the sheet is taken away by a chain gripper transport system 21, known per se in the art of printing machines, and is delivered in a pile delivery system. Preferably, the sheets are sorted in this delivery system, i.e. the defective (marked) sheets are put in a defective pile and the sheets with no defects are put in another pile. As is known in the art, the successive sheets are held on said transfer cylinders 17 and 18 by gripper means placed in a pit of the cylinders.

Preferably, the cameras used are linear CCD cameras that take successive linear images of the sheet being inspected. Therefore, in order to be able to take the proper image of the entire sheet being inspected, they are synchronized with the sheet transport on the cylinders 4, 7 and 12 through an encoder of said cylinders. In order to have a perfect match between the encoder reading of each cylinder 4, 7 and 12 and camera image taking, the sheet must be completely inspected before they are transferred to the next inspection cylinder. The relative position of the cylinders must be such that this condition of complete inspection before transfer is maintained. In this case, the sheets can be properly inspected and the transfer operation from one cylinder to another does not influence the inspection operation per se.

Preferably, the transfer and inspection cylinders 3,4,7,12,17 are arranged in a zigzag manner, as shown in figure 1, such that a transport length of a printed sheet on each inspection cylinder, between an input location where a printed sheet is transferred onto the inspection cylinder and an output location where the printed sheet is transferred away from the inspection cylinder is optimised for a given sheet length. In particular, the transport length of the printed sheet on the inspection cylinder between the input and output locations is selected to be slightly greater than the length of the printed sheet to be inspected. It will be understood that this configuration allows to reduce to a minimum the overall transport path of the sheets through the inspection units, thereby minimizing the transport and inspection times of the sheets. Indeed, with the machine configuration illustrated in figure 1, the transport length between the input location on the first

inspection cylinder 4 and the output location of the third inspection cylinder 12 is slightly greater than three times the length of the inspected sheets. Combined with cylinders of minimal size, this further allows to build a machine with a very compact configuration.

Preferably, as shown in figure 1 by way of a non-limiting but advantageous example, the cylinders are dimensioned to carry one single sheet to be inspected. Of course, other configurations could be envisaged in which two or three sheets are carried by each cylinder.

Preferably, the transfer and inspection cylinders are carrying only one set of grippers each (each cylinder being thus adapted to transport one sheet at a time), and the diameter of the cylinders is minimized for minimal transport and inspection time while maintaining the conditions defined of transfer only once the inspection is finished. In the machine configuration shown in figure 1, the transfer cylinders 3, 17 and the inspection cylinders 4, 7, 12 advantageously have the same diameters.

In figure 2 a block-diagram of an inspection process is disclosed.

In a first step, the successive sheets to be inspected are transferred from the feeder into a first inspection unit in which the inspection by transparency is carried out.

Then, once this inspection has been done, the sheets are transferred to a second inspection unit in which a second inspection is carried out, for example on a recto side of the sheets. In this second inspection unit, it is possible

to control visible features of the printing (ink, colors, registration) and non-visible features (IR, UV, magnetic properties).

After this second inspection is terminated, the sheets are transferred to a third inspection unit similar to the second inspection unit but it is the other side (for example the verso side) of the sheets that is inspected in a similar manner, i.e. the visible and non-visible features are controlled.

Once this third inspection is terminated, the sheets inspected are transferred in a marking unit and are marked if the result of one of the inspection is a fail (that is the sheet has a defect).

Finally, the sheets are transported in a delivery unit and sorted in delivery piles (with or without defect) which then can be used for further processing of the inspected sheets.

Of course, in the machine of figure 1, the respective positions of the different inspections unit may be varied and it is possible to first inspect a side of the sheets (recto or verso), then another side (verso or recto) and then to carry out the transparency inspection.